Draft Stream Relocation/Mitigation Guidelines

KY Division of Water, December 2002 (Updated 10-15-07)

This document is intended to provide guidance to applicants for 401 Water Quality Certification with projects involving stream relocations or stream mitigation. This document is a draft and therefore subject to change. It is strongly recommended that you contact the 401 Water Quality Certification Section of the Kentucky Division of Water (KDOW), prior to the submission of an application, to confirm that you have the most current version of this document. Additional information may be required on a case-by-case basis. If you have any questions regarding these guidelines, please contact the Water Quality Certification Section at (502) 564-3410.

Information in this document is broken into the following sections:

Section 1: Mitigation
Section 2: Data required supporting stream relocation projects
Section 3: General criteria for stream relocation projects
Section 4: Physical monitoring requirements for stream relocation/mitigation projects
Section 5: Biological monitoring of stream projects
Section 6: Compensatory Mitigation Guidelines
Section 7: Example Calculations for Mitigation Work

Attachments are as follows:

Attachment 1: Typical longitudinal thalweg profile
Attachment 2: Permanent monuments
Attachment 3: Typical channel cross-section
Attachment 4: Typical plan view
Attachment 5: Sample photograph showing a downstream view of the lower half of a bend
Attachment 6: Data Summary Sheet
Attachment 7: Habitat Assessment Sheets
Attachment 8: Suggested Riparian Species List
Attachment 9: Native Seed and Plant Resources

Section 1: Mitigation

1. The KDOW may require compensatory mitigation for most permanent stream losses based on the Water Quality Certification Conditions of the USACE 2007 Nationwide Permits. Stream loss is restricted to intermittent or perennial streams.

2. Impacts that result in partial loss of a stream resource may also require mitigation. Partial losses include, but are not limited to, activities that result in elimination of in-stream habitat, armoring of the channel, widening or deepening the channel, and relocations that can not follow natural channel designs or lack riparian zones. Resource losses associated with the impoundment of streams will be assessed on an individual basis and may require mitigation.

3. The Water Quality Certification (WQC) issued by KDOW must certify that which is permitted by the Corps of Engineers meets the Water Quality Standards of Kentucky. Therefore, if the Corps requires compensatory mitigation for impacts, project plans submitted to KDOW must reflect the Corps' requirements.

4. Please contact the Water Quality Certification Section at (502) 564-3410 to help you determine your mitigation requirements.

Section 2: Data required to support stream relocation projects

1. Where it is necessary to relocate a stream channel, the KDOW expects a stream relocation design based on fluvial geomorphologic principles so that the relocated stream restores both biological and hydraulic functions of a natural stream. Objectives of the relocation project must include creating a naturally stable system that transports its sediment and restores habitat.

2. In general, natural channel design is composed of three main components:
   - Naturally stable planform and profile.
   - Appropriate in-stream habitat (structures and self-perpetuating features).
   - Minimum 50' wide riparian zone on each side of the stream channel.

3. Where site conditions prevent this type of design, the impact may be considered a permanent loss of the aquatic resource and compensatory mitigation would be required.

4. The following data shall be required for the stream to be existing stream. In most instances, the stream to be relocated can be used as the source for these data. If the existing stream is unstable, the use of a reference reach is required. Attachment 6 is a data summary sheet that must be completed as the project progresses.

   Project Information
   - Name and location of the project and affected stream, drawn on a USGS 7.5' topographic map
   - Watershed size, in acres, above the furthest downstream point of the proposed disturbance, and any off-site mitigation areas
   - Description of the type(s) of proposed disturbance (e.g., fill, culverting, relocation, etc.)
   - Linear feet of proposed stream disturbance
   - Linear feet of permanent stream "loss," and linear feet of stream to be restored on-site and off-site. Stream loss includes filling, culverting, channelizing and loss of aquatic habitat.
   - Statement of project objectives and success criteria

   Stream Information
   - Level II stream type (Rosgen 1996)
   - Bankfull discharge flow (Q_{bkf}) expressed in cubic feet per second
   - Substrate description consisting of a pebble count at a riffle(s) area and a sieve sample from a gravel bar. Information must be presented in a sediment curve. See Section 4 for details on appropriate methodology and reporting.
   - Dimensionless critical shear stress and critical shear stress values, including the formulas and particle measurements used to calculate these values. The formulas and particle measurements used to calculate these values must also be reported.
   - Assessment of the existing channel stability and prior impacts, such as: channel alterations, severe bank erosion, excessive sedimentation, embeddedness, headcutting/downcutting, and exposed bedrock

Geomorphic Information

- Longitudinal Information: bankfull water surface elevation, channel slope, valley slope, pool and riffle slope, depth of riffles and pools. These measurements must be shown on a longitudinal thalweg profile. Profiles must be provided for the impact reach, reference stream segment, and the post-construction channel. See Section 4 for appropriate procedures and Attachment 1 for an example.
- Planform Information: sinuosity (K), belt width (W_{blt}), radius of curvature (of meanders (R_c), meander wavelength (L_m), floodprone width (W_{fp}), riffle-pool ratio, and placement. These features must be shown on a plan view. Plan views must be provided for the reference stream segment as well as the post-construction channel. See Section 4 for more details on information required for the proposed channel, and Attachment 4 for an example. For stream relocations, the plan view must clearly show the pre-construction channel in relation to the new channel.
- Cross-sectional Information: channel width and depth (riffles and pools); bankfull discharge area (A_{bkf}), width (W_{bkf}), and elevation; wetted perimeter (WP); entrenchment ratio (ER); hydraulic radius (R); and floodprone width (W_{fp}) and area (A_{fp}). These features (except R, ER) must be shown on the typical cross-sections. Cross-sections must be taken for bend areas and straight reaches. Typical cross-sections must be provided for the reference stream segment as well as the post-construction channel. See Section 4 for appropriate procedures and Attachment 3 for an example.

Technical Information

- A description of measures and materials to be used to create aquatic habitat within the restored/enhanced channel
- If applicable, a description of grade control measures to be employed
- If any artificial structures such as cross vanes, j-hooks or constructed riffles are proposed, the locations of the structures must be included in the planform and design specifications. Detail sheets on all structures must also be included in the permit package.
- A description of existing riparian conditions along the affected stream reach, including dominant species present and width of the existing riparian area, and a revegetation plan for the restored/enhanced stream reach(es)
- Sediment and erosion control plans. When feasible, no water should be released into the new channel until construction is complete and the site is stabilized.
- Monitoring Plan (see Section 4)
- A description of permanent protection measures and supporting documentation
- Mitigation schedule (month/year work will begin and expected completion date-month/year)
- A contingency plan i.e., if the relocation fails, what steps will be taken to correct the problem(s)?

A reference stream is critical in designing a new channel. In some situations, the existing channel that is to be relocated provides an appropriate reference. However, there are times when the existing channel is not appropriate due to physical degradation and alterations. Examples include situations where the existing channel has been straightened, shortened, widened, or otherwise altered so that it no longer represents a natural system. In these situations, the selection of an off-site reference is necessary. The off-site reference stream should be similar to the channel to be relocated with regard to watershed size, flow at bankfull discharge, valley

slope, and substrate. Reference reaches should be located as close as possible to the impacted reach, within the same watershed or stream whenever possible.

It is strongly recommended that applicants contact KDOW after selection of an off-site reference stream, for concurrence on appropriateness. **This should be done prior to taking all of the required field measurements.**

See also: "The Reference Reach – A blueprint for natural channel design" by: David L. Rosgen." Published by: ASCE conference, March 1998 (http://wildlandhydrology.com/assets/The_Reference_Reach_II.pdf).

Section 3: General criteria for stream relocation projects

1. The permitted stream relocation design must be constructed in accordance with the approved plans. No field changes may be made without prior approval of KDOW.

2. Widening of the stream channel over its pre-impact width may only occur above bankfull elevations. The re-creation of a floodplain above bankfull is encouraged.

3. Revegetation of the new channel must begin at the bankfull elevation and extend up the stream bank for a minimum horizontal distance of 25 feet. Successful riparian restoration will consist of at least 4 native tree/shrub species with a minimum density of 300 live stems per acre after 3 years. Up to 50% of the 300 stems/acre may be volunteers. Tree rows should be staggered and species should be alternated, with no species exceeding 25% of the total plantings.

4. Attachment 8 includes a list of recommended species for riparian plantings. This list is not intended to limit any options or to provide a "cookbook" recipe for developing a riparian planting plan. Selections must be native to the project area and appropriate for the specific on-site conditions.

Section 4: Physical monitoring requirements for stream relocation/mitigation projects

Projects that involve relocation or restoration for compensatory mitigation will typically require annual physical monitoring for a period of three to eight years. This monitoring period is required to evaluate the success of the project in terms of stability and compliance. Annual monitoring reports are due to the KDOW by December 31st of the year in which project construction is initiated, and typically continue for four years following the completion of project.

Monitoring periods may be either reduced or extended depending on the success of the project. Relocation/mitigation projects that are deemed stable and in compliance with monitoring and design requirements after three years may not require additional monitoring. However, improper monitoring or signs of instability may increase the monitoring period. Staff from KDOW will periodically conduct on-site evaluates of projects for compliance during the monitoring period.

This document covers only the requirements for physical monitoring of restoration/relocation sites. Projects that involve stream enhancement will require some reduced level of monitoring that will be established on a case-by-case basis.

REQUIRED INFORMATION

The following information is required of each project that has a monitoring condition placed on its Water Quality Certification.

1. **As-Built Survey** – upon completion of project construction, an as-built drawing must be submitted to the Water Quality Certification Section. This will include much of the same information as was submitted for the original or reference channel. Please refer to the USFS General Technical Report RM-245 for appropriate surveying procedures.
   - Longitudinal thalweg profile that shows:
     - Channel slope – requiring at a minimum, surveyed points at the heads of riffles and pools and at the maximum pool depth
     - Valley slope
     - Bankfull water surface elevation at riffles and pools
     - Points at each established cross-section and at structures must be referenced in the longitudinal profile to ensure comparison of replicate surveys. A sample profile showing the minimum information is provided in Attachment 1.

   - Cross-sections for:
     - The downstream 1/3 of each bend
     - typical straight sections
     - 20 to 50 feet up and down stream of the project reach

     Cross-sections must include the following: a minimum of 20 channel ground elevations, and sufficient ground elevations to describe the valley section, bankfull elevation, thalweg, top of bank, and any other important feature in the cross-section. Information shown in Attachment 3 is required, at a minimum. Concrete

monuments must be installed at the locations of the permanent cross-section stations.

- Permanent concrete monuments must be appropriately placed for all permanent cross-sections to provide a consistent location for future measurements of cross-sections. The monuments must be placed at least 10 ft back from top of bank. The location (x,y coordinates) and elevation (z) of each monument must be obtained and provided with the as-built plans. The monument must be designed as described in Attachment 2.

- Plan view that shows the locations of:
  - All artificial structures (e.g. vanes, grade-control structures, and bank protection)
  - Permanent cross-sections
  - Channel planform characteristics (bends including radius of curvature, pools and riffles)
  - Valley characteristics (belt width, floodprone width, riparian zone)
  - Locations and coordinates of permanent monuments
  - The plan view must also show any changes to the relocation/mitigation plan made during construction. See Attachment 4 for a sample plan view.

These measurements must be surveyed within 60 days after project construction (for submission with the first annual monitoring report) and again in the third year. Additional surveys may be required if the monitoring period is extended.

2. **Permanent picture stations** must be established where pictures can be taken biannually (summer/winter). Photographic documentation of the success of the project is required with each monitoring report.
   - One station must be established downstream of each structure to provide an upstream view of the structure such that each large rock within the structure is visible.
   - One station must be established at each bend such that a downstream view of the downstream ½ of each bend is visible. See Attachment 5.
   - Photographs must also show riparian planting and erosion control measures.

   The number of stations required for a project will vary depending on project length. Additional stations may be required to show areas where aggradation, degradation, erosion, and mid-channel bars have developed. Summer pictures must focus on documenting the vegetation, while winter photos must show the stream stability and geomorphology. Erosion and sediment control measures must also be documented. Proposed locations of the photograph stations must be submitted with the monitoring plan, with arrows indicating the direction the picture will be taken. Photographs must include a detailed description of the view and label any problem areas identified during monitoring. Pictures must be color and a minimum of 4" by 6."

3. **Riffle and Channel Pebble Counts** must be taken following the modified Wolman procedure (Rosgen 1993). Pebble counts are required during the second year of monitoring.

- The riffle 100-pebble count must be limited to the active channel and should not include bank material.
- Overall channel pebble counts must include particles from pools, glides, runs and riffles. A minimum of 100 measurements must be taken, although a 200-pebble count may be more appropriate for longer projects.

Data are to be submitted in the form of a sediment curve showing "percent finer than" on the y-axis and particle size (millimeters) on the x-axis using log-scale paper.

4. **Bar Samples** – At least one bar sample must be taken upstream, within, and downstream of the project reach. The procedure must follow that described in Chapter 7 of Rosgen (1996). This information is to be included on the sediment curve. Bar sampling is required during the second year of monitoring. Bar sample locations must be identified on the plan view.

5. **Vegetative Monitoring** of the riparian zone is required annually. The following success measurements are to be reported annually:
   - Species composition, including density and percent cover
   - Top five dominant species per stratum
   - Percent survival of planted trees and shrubs
   - Stems/acre trees and shrubs, including planted, and planted + volunteers
   - No more than 10% exotic invasive species must be present in the final percent cover survey
   - Exotic species include those on the most recent Kentucky Exotic Pest Council Lists 1 & 2 (http://www.se-eppc.org/ky/list.htm).

6. **Habitat assessment of stream projects** - The KDOW will require annual habitat assessments for all stream restoration and relocation projects. Sheets must be complete for each distinct project reach. When biological monitoring is required, sheets must be completed for each sampling location. Habitat assessment procedures follow those outlined in *Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers* (Barbour et al. 1999). Annual assessments are to be completed by the same personnel, whenever possible, to ensure consistency.

   Attachment 7 of this document contains appropriate data sheets for these assessments. A description of these procedures can be found in Section 6 – Habitat Assessment of the July 2002 Methods for Assessing Biological Integrity of Surface Waters. This manual can be found at http://www.water.ky.gov/sw/swmonitor/sop/.

NOTE – In streams where the previously listed sediment sampling procedures (pebble counts, bar sample) are inappropriate, a suitable alternative must be proposed.

Section 5: Biological monitoring of stream projects

The KDOW will require biological monitoring of stream restoration projects on a case-by-case basis. When biological monitoring is required, the July 2002 Methods for Assessing Biological Integrity of Surface Waters developed by the KDOW must be followed. This manual can be found at http://www.water.ky.gov/sw/swmonitor/sop/.

Once it is determined that biological monitoring is required for a project, the applicant must submit a proposed sampling plan to the KDOW for approval. The plan must include detailed descriptions of all proposed sample locations, including reference sites and sites within the project area.

Baseline sampling will be required prior to project construction. After construction, biological monitoring will be required for some period time to be specified in the Water Quality Certification.

Section 6: Compensatory mitigation guidelines

When a project results in the permanent loss of a stream, the applicant may be obligated to provide compensatory mitigation for that loss. The linear distance of loss shall be converted to a number of "credits" that must be provided as compensation on a 1:1 basis. For example, 1000 feet of loss in a water of the Commonwealth will require 1000 credits of compensatory mitigation.

The following is a listing of activities that will generate mitigation credits. Section 7 provides an illustration of how to calculate credits for each activity.

Daylighting + Full Restoration = 1.0 x the length of work.

The process of removing pipes or culverts, exposing buried (filled) streams, removing concrete channels, or removing dams/impoundments. This form of daylighting includes full restoration of the stream by returning the stream to its natural state based upon reference conditions for the appropriate valley type, with appropriate geomorphic dimensions, sediment transport dynamics, in-stream habitat enhancement and riparian vegetation re-establishment.

Daylighting + Enhancement = 0.8 x the length of work.

The process of removing pipes or culverts, exposing buried (filled) streams or removing concrete channels, and improving the stream at its existing location with respect to aquatic habitat, channel stability, flow or sediment transport dynamics. Refer to the following discussion of "enhancement" for more details regarding this level of work.

Full-scale Restoration = 0.8 x the length of work.

The process of converting an unstable, altered, or degraded stream corridor, including the adjacent riparian and flood prone areas, to its natural, stable condition considering recent and future watershed factors such as urbanization. This process is based upon reference conditions for the appropriate valley type; with appropriate geomorphic dimensions, sediment transport dynamics, in-stream habitat enhancement and riparian vegetation re-establishment.

Stream Enhancement = 0.2 to 0.6 x length of work.

Enhancement involves the improvement of a stream in its existing location with respect to aquatic habitat, channel stability, flow or sediment transport dynamics, but falls short of full-scale restoration. Enhancement projects have three possible components that can be implemented either individually or in combination:

- Riparian establishment.
- Bank stabilization.
- In-channel work.

Each component is worth 0.2 credit, for a possible total of 0.6 if all three components are employed along a given reach of stream.

- Riparian establishment must be a minimum of 25 feet, perpendicular to and beginning at the new bankfull elevation. If riparian vegetation is established along only one side of the stream, then only ½ credit will be given (0.1).
- Bank stabilization includes the regrading and placement of materials onto a stream bank to correct erosion or stability problems as well as lowering bank heights to bankfull elevations and excavating the floodplain. Only habitat enhancement stabilization techniques will be given credit, which may include bioengineering, live staking, tree planting, rock toes, and improving access to the floodplain. Hard revetment such as extensive rip rapping, concrete, grout, gabions or retaining walls will not receive mitigation credit.
- In-channel work includes: reconfiguration of the stream cross-section to improve sediment transport and flow dynamics, improving access to the floodplain, installation of grade control structures, and creation of aquatic habitat structures. Examples of aquatic habitat, grade control and flow control structures include: cross vanes, J-hook weirs, boulders, root wads, deflectors and riffles. Justification for the addition of these structures must be included with the proposal.

All of the above compensatory mitigation activities require permanent protection of the work area through a conservation easement, deed restriction or other permanent protection measure to receive credit as compensatory mitigation.

Preservation = 0.1 x length of work.

Where preservation of an existing stream corridor is proposed without other stream work, a credit value of 0.1 will be applied. This type of compensatory mitigation will require the permanent protection of the work area through a conservation easement, deed restriction or other permanent protection measure in order to receive credit as a compensatory mitigation site.

Another compensatory mitigation option is the payment of a monetary fee in lieu of mitigation to an organization approved by the Corps of Engineers and the KDOW. The in-lieu fee recipient would then be responsible for the compensatory mitigation.

Several factors may modify the above credit totals:

A. An additional 25% credit will be given for the above activities if:
   1. The work is done on a stream listed on the KDOW 303d list.
   2. The work is done on a stream listed as a "priority" watershed by a KDOW recognized basin management team.
   3. The KDOW reserves the right to approve this additional credit based on whether or not the mitigation work addresses the reason for impairment.

B. When one of the above compensatory mitigation activities is proposed outside of the major drainage basin (6 Digit H.U.C. Unit) in which the loss occurred, the total credits will be decreased by 1/3.

Section 7: Example Calculations for Mitigation Work

As an example, if a mitigation project involves a total of 1000 linear feet of work:

- 500 feet are to be restored to the original channel following natural channel design;
- 300 feet involve bank stabilization and the replacement of a 25 foot riparian zone on both sides of the creek and;
- 200 feet involve the replacement of the riparian zone on one side of the creek. The calculations are as follows.

REACH	LENGTH (L.F.)	LEVEL OF RESTORATION	TOTAL CREDITS
1	500	0.8	400
2	300	0.4	120
3	200	0.1	20
TOTAL	1000		540 FEET

LITERATURE CITED

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid bioassessment protocols for use in wadeable streams and rivers: periphyton, benthic macroinvertebrates, and fish (2nd edition). The United States Environmental Protection Agency, Washington, D.C. EPA 841-B-99-002.

Harrelson, C.C., C. L. Rawlins, and J.P. Potyondy. 1994. Stream channel reference sited: an illustrated guide to field technique. Gen. Tech. Rep. RM-245. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 61p.

Rosgen, D. L. (1993): Applied Fluvial Geomorphology, Training Manual. River Short Course, Wildland Hydrology, Pagosa Springs, CO.: 450 pp.

Rosgen, D.L. (1996): Applied River Morphology. Wildland Hydrology, Pagosa Springs, CO.

CHECKLIST OF REQUIRED INFORMATION

PRE-CONSTRUCTION – see Section 2

1. Statement of project objectives
2. Statement of success criteria
3. Restoration/relocation design
4. Monitoring plan including a plan view showing locations of permanent cross-section stations, photographing stations
5. Contingency plan
6. Habitat assessment

YEAR 1

1. As-built survey
   - Longitudinal profile
   - Cross-sections
   - Planview
2. Photographs
3. Vegetation monitoring
4. Habitat assessment

YEAR 2

1. Pebble counts
   - One reach-wide
   - Riffles – at permanent cross-section locations
2. Bar sample
3. Photographs
4. Vegetation monitoring
5. Habitat assessment

YEAR 3

1. As-built survey
2. Photographs
3. Vegetation monitoring
4. Habitat assessment
5. Assessment of project success

YEAR 4

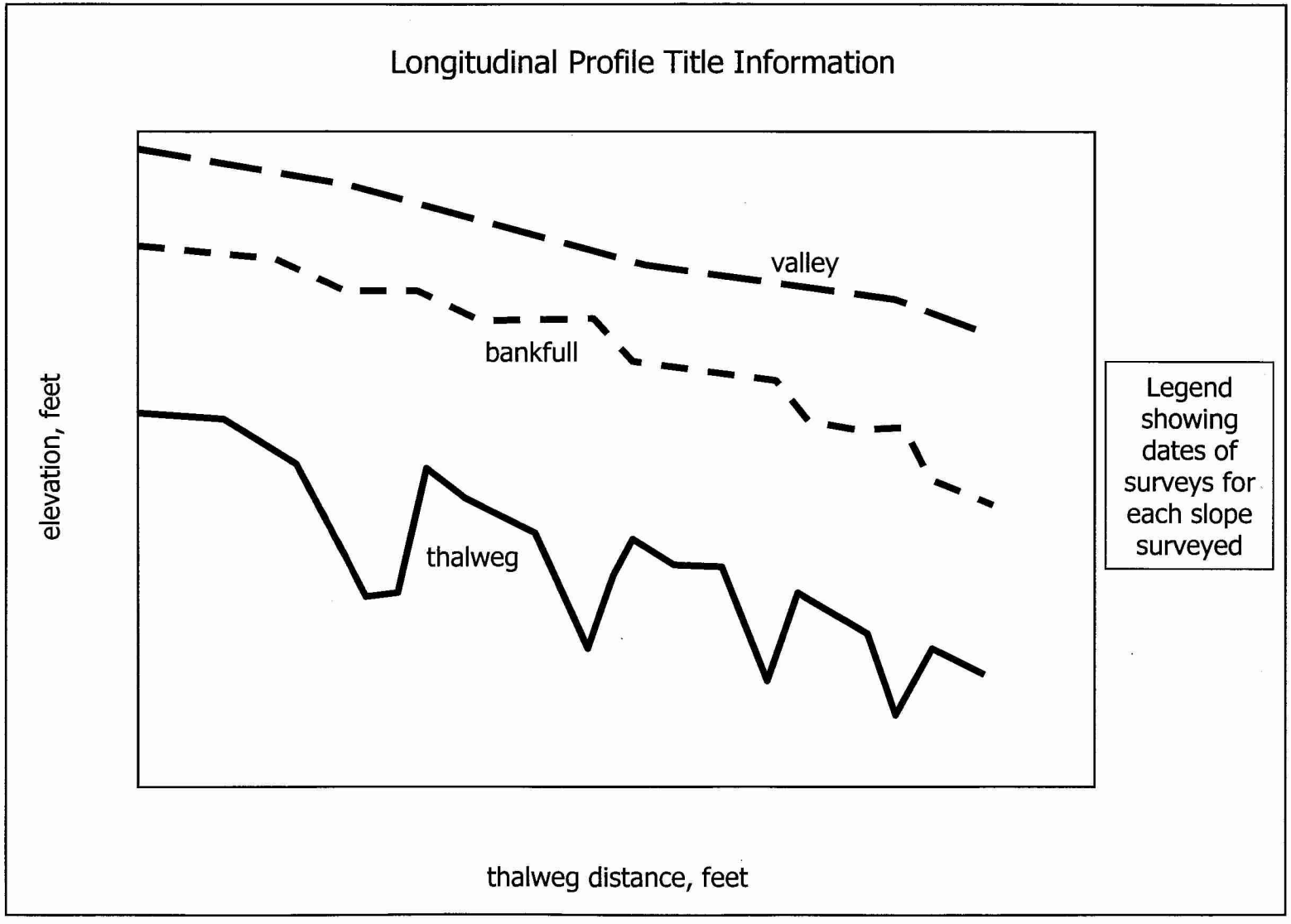
1. Photographs
2. Vegetation monitoring
3. Habitat assessment
4. Other data as required by KDOW

YEAR 5 – 8

1. Data as required by KDOW

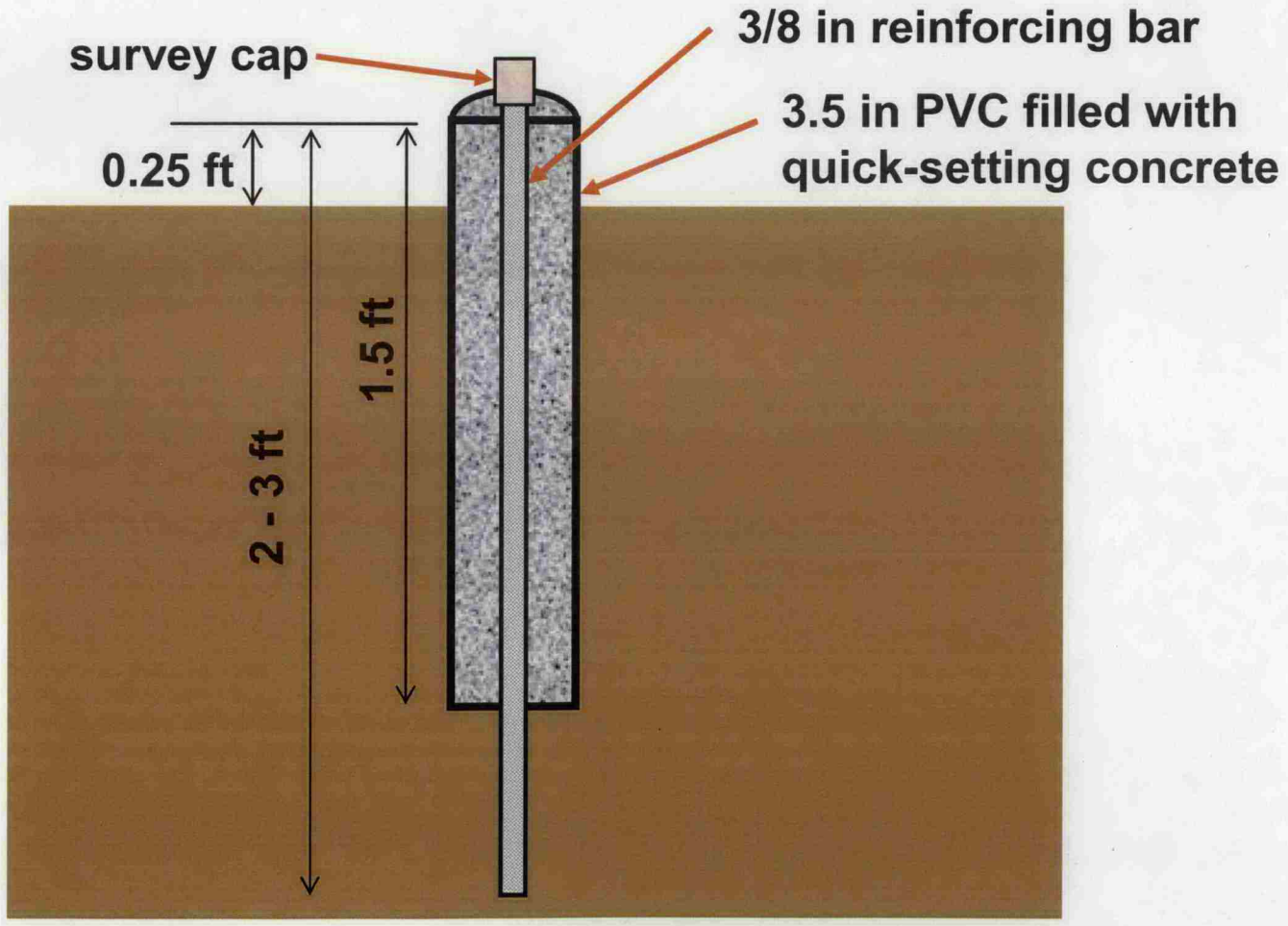
ATTACHMENT 1

Typical Longitudinal Thalweg Profile



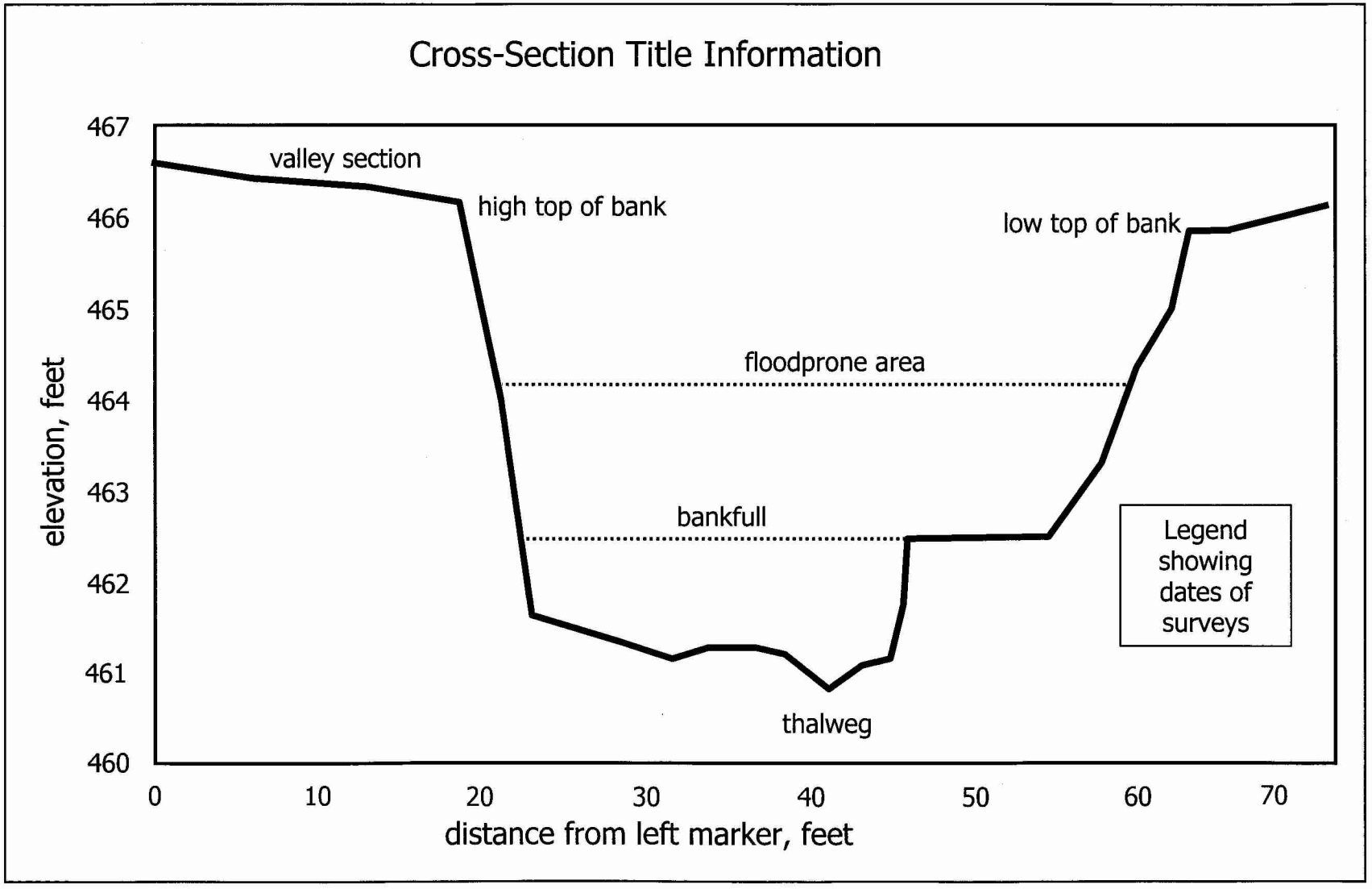
ATTACHMENT 2

Cross-Sections Survey Monument



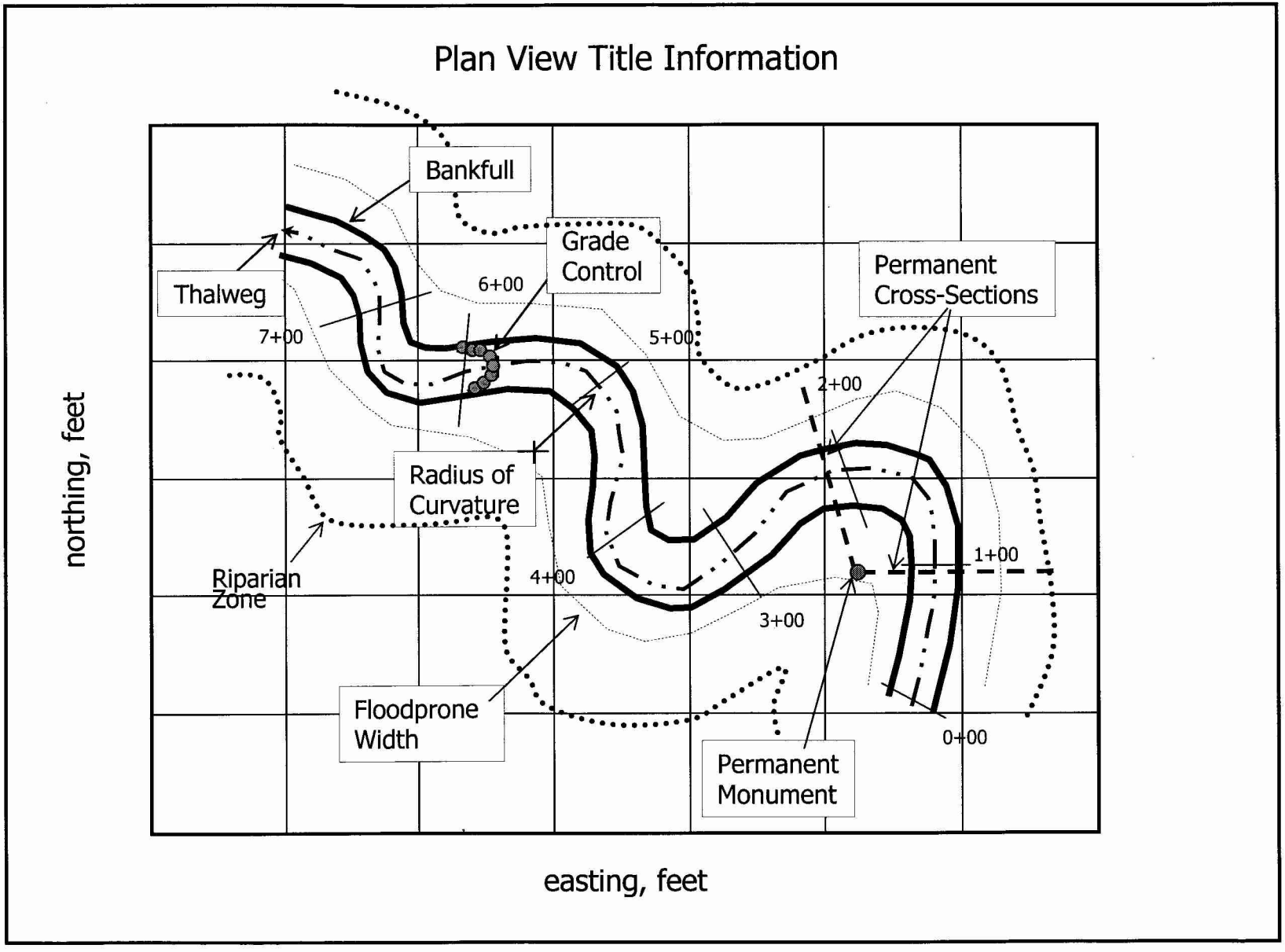
ATTACHMENT 3

Typical Channel Cross-Section



ATTACHMENT 4

Typical Plan View



ATTACHMENT 5

Downstream View of Lower-half of Bend

ATTACHMENT 6

Data Summary Sheet

	Existing	Reference	Proposed	As-Built (year 1)	Year 3
Stream Name					
Drainage Area (acres)					
Rosgen Stream Type (Level II)					
Bankfull Discharge Flow (Q_{bkf})					
D_{50} Riffle/Pavement					
D_{50} Bar/Subpavement					
D_{100} Bar/Subpavement					
τ_{cr}*					
τ_{cr}					
Channel slope					
Valley slope					
Riffle slope					
Pool slope					
Sinuosity					
Ave. Riffle Depth (@ BKF)					
Max. Riffle Depth (@ BKF)					
Ave. Pool Depth (@ BKF)					
Max. Pool Depth (@ BKF)					
Belt Width					
Radius of Curvature					
Meander Wavelength					
Floodprone Width					
Bankfull Width					
Floodprone Area					
Bankfull Area					
Entrenchment Ratio					
Width:Depth Ratio					
Wetted Perimeter					
Hydraulic Radius					

ATTACHMENT 7a

High Gradient Stream Data Sheet

STREAM NAME:	LOCATION:
STATION #: MILE:	BASIN/WATERSHED:
LAT.: LONG.:	COUNTY: USGS 7.5 TOPO:
DATE: TIME: ☐AM ☐PM	INVESTIGATORS:

TYPE SAMPLE: θ P-CHEM θ Macroinvertebrate θ FISH θ BACT.

WEATHER:

Now	Past 24 hours
θ	θ Heavy rain
θ	θ Steady rain
θ	θ Intermittent showers
θ	θ Clear/sunny

Has there been a heavy rain in the last 7 days?
θ Yes θ No
Air Temperature _____ °C. Inches rainfall in past 24 hours _____ in.
_____ % Cloud Cover

P-Chem: Temp(°C)_____ D.O. (mg/l)_____ %Saturation_____ pH(S.U.)_____ Cond._____ θ Grab

INSTREAM WATERSHED FEATURES:

Stream Width	_____ ft
Range of Depth	_____ ft
Average Velocity	_____ ft/s
Discharge	_____ cfs
Est. Reach Length	_____

LOCAL WATERSHED FEATUREES:
Predominant Surrounding Land Use:

θ Surface Mining	θ Construction	θ Forest
θ Deep Mining	θ Commercial	θ Pasture/Grazing
θ Oil Wells	θ Industrial	θ Silviculture
θ Land Disposal	θ Row Crops	θ Urban Runoff/Storm Sewers

Hydraulic Structures:
θ Dams θ Bridge Abutments
θ Island θ Waterfalls
θ Other

Stream Flow:
θ Dry θ Pooled θ Low θ Normal
θ High θ Very Rapid or Torrential

Stream Type:
θ Perennial θ Intermittent
θ Ephemeral θ Seep

Riparian Vegetation: Dom. Tree/Shrub Taxa
Dominate Type:
θ Trees θ Shrubs
θ Grasses θ Herbaceous
Number of strata ____

Canopy Cover:
θ Fully Exposed (0-25%)
θ Partially Exposed (25-50%)
θ Partially Shaded (50-75%)
θ Fully Shaded (75-100%)

Channel Alterations:
θ Dredging
θ Channelization
(θFull θPartial)

Substrate θEst. θP.C.	Riffle_____%	Run_____%	Pool_____%
Silt/Clay (<0.06 mm)			
Sand (0.06 – 2 mm)			
Gravel (2-64 mm)			
Cobble (64 – 256 mm)			
Boulders (>256 mm)			
Bedrock			

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Sow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

ATTACHMENT 7a

4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr.) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8.Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Total Score [ ] **NOTES/COMMENTS:**

ATTACHMENT 7b

Low Gradient Stream Data Sheet

STREAM NAME:	LOCATION:
STATION #: MILE:	BASIN/WATERSHED:
LAT.: LONG.:	COUNTY: USGS 7.5 TOPO:
DATE: TIME: ☐AM ☐PM	INVESTIGATORS:

TYPE SAMPLE: θ P-CHEM θ Macroinvertebrate θ FISH θ BACT.

WEATHER:

Now	Past 24 hours
θ	θ Heavy rain
θ	θ Steady rain
θ	θ Intermittent showers
θ	θ Clear/sunny

Has there been a heavy rain in the last 7 days?
θ Yes θ No
Air Temperature _____ °C. Inches rainfall in past 24 hours _____ in.
_____ % Cloud Cover

P-Chem: Temp(°C)_____ D.O. (mg/l)_____ %Saturation_____ pH(S.U.)_____ Cond._____ θ Grab

INSTREAM WATERSHED FEATURES:

Stream Width	_____ ft
Range of Depth	_____ ft
Average Velocity	_____ ft/s
Discharge	_____ cfs
Est. Reach Length	_____

LOCAL WATERSHED FEATUREES:
Predominant Surrounding Land Use:

θ Surface Mining	θ Construction	θ Forest
θ Deep Mining	θ Commercial	θ Pasture/Grazing
θ Oil Wells	θ Industrial	θ Silviculture
θ Land Disposal	θ Row Crops	θ Urban Runoff/Storm Sewers

Hydraulic Structures:
θ Dams θ Bridge Abutments
θ Island θ Waterfalls
θ Other _____

Stream Flow:
θ Dry θ Pooled θ Low θ Normal
θ High θ Very Rapid or Torrential

Stream Type:
θ Perennial θ Intermittent
θ Ephemeral θ Seep

Riparian Vegetation: Dom. Tree/Shrub Taxa
Dominate Type:
θ Trees θ Shrubs
θ Grasses θ Herbaceous
Number of strata _____

Canopy Cover:
θ Fully Exposed (0-25%)
θ Partially Exposed (25-50%)
θ Partially Shaded (50-75%)
θ Fully Shaded (75-100%)

Channel Alterations:
θ Dredging
θ Channelization
(θFull θPartial)

Substrate θEst. θP.C.	**Riffle_____%**	**Run_____%**	**Pool_____%**
Silt/Clay (<0.06 mm)			
Sand (0.06 – 2 mm)			
Gravel (2-64 mm)			
Cobble (64 – 256 mm)			
Boulders (>256 mm)			
Bedrock			

Habitat	**Condition Category**			
Parameter	**Optimal**	**Suboptimal**	**Marginal**	**Poor**
1. Epifaunal Substrate/ Available Cover	Greater than 50% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	30-50% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud or clay or sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root mat or vegetation.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Pool Variability	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present.	Majority of pools large-deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or pools absent.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

ATTACHMENT 7b

4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 20% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 20-50% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 50-80% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; 80% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
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5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
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SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Channel Sinuosity	The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line. (Note - channel braiding is considered normal in coastal plains and other low-lying areas. This parameter is not easily rated in these areas.	The bends in the stream increase the stream length 2 to 3 times longer than if it was in a straight line.	The bends in the stream increase the stream length 2 to 1 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a long distance.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8.Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
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SCORE (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
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10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Total Score [ ] **NOTES/COMMENTS:**

ATTACHMENT 8

Suggested Riparian Species List

The species on list are only suggestions. Native species that are appropriate for a given site may be proposed.

Herbaceous Species

Rice cutgrass	*Leersia oryzoides*
Managrass	*Glyceria striata*
Spangle grass	*Chasmanthium latifolium*
Switchgrass	*Panicum virgatum*
Annual rye	*Secale cereale*
Wild rye	*Elymus virginicus*
Deertongue grass	*Panicum clandestinum*
Panic grass	*Panicum microcarpon*
Giant Cane Bambo	*Arundinaria gigantea*

Tree Species

Pin Oak	*Quercus palustria*
Cherrybark Oak	*Quercus pagoda*
Bur Oak	*Quercus macrocarpa*
Swamp Chestnut Oak	*Quercus michauxii*
Shingle Oak	*Quercus imbricaria*
Northern Red Oak	*Quercus rubra*
Post Oak	*Quercus stellata*
Red Maple	*Acer rubrum*
Green Ash	*Fraxinus pennsylvanica*
Shellbark Hickory	*Carya laciniosa*
Blackgum	*Nyssa sylvatica*
American Elm	*Ulmus americana*
Eastern Cottonwood	*Populus deltoides*
Black Walnut	*Juglans nigra*
River Birch	*Betula nigra*
Yellow Poplar	*Liriodendron tulipifera*
Persimmon	*Diospyrus virginiana*

Shrubs

Arrow-wood	*Viburnum dentatum*
American Plum	*Prunus americana*
Deciduous Holly	*Ilex decidua*
Gray Dogwood	*Cornus racemosa*
Silky Dogwood	*Cornus amomun*
Spicebush	*Lindera benzoin*
Sassafrass	*Sassafras albinum*

ATTACHMENT 9

NATIVE SEED AND PLANT RESOURCES

The following is a list of known native seed and plant vendors in the Commonwealth of Kentucky. The names are listed in no particular order and the presence of a vendor's name does not indicate endorsement by the division. If you would like to be referenced on this page, please send (1) a resume outlining relevant education, training and experience, and (2) your company's Internet and e-mail addresses to Teresa Welch, Division of Water, Water Quality Certification Section, 14 Reilly Rd., Frankfort, KY 40601.

Shooting Star Nursery
160 Soards Road
Georgetown, KY
(502) 867–7979
http://www.shootingstarnursery.com/

Dropseed Native Plant Nursery
13930 Brush Run Road
Louisville, KY 40299
(502) 762–1080
http://www.dropseednursery.org/

Caudill Seed Company
1201 Story Avenue
Louisville, KY 40206
(502) 583-4402
http://www.macraesbluebook.com/search/company.cfm?company=519074